

4.0 EXISTING ECONOMIC ESTIMATES OF THE COSTS OF CATARACTS

4.1 INTRODUCTION

This section presents currently available literature and data on the cost of illness measures of cataracts (damage to the affected individuals). Updated estimates from Denver area caregiver's are also provided. These data both serve to improve the understanding of the impacts of cataracts and to provide a summary of available cost of illness estimates and who pays these costs.

It has been recognized that the costs of cataracts, both to the individual and to society, are great. The National Eye Institute (NEI) has reported that if the need for cataract surgery could be delayed for 10 years, the number of cataract extractions in the U.S. would be reduced by 45 percent (National Eye Institute, 1983).¹ Such a reduction would represent a savings of over \$600 million a year in medical costs alone (based on a reduction in the number of surgeries performed in 1981 from an estimated 541,000 to 298,000, at an average 1981 cost of \$2,500 dollars). When one also considers the gains in productivity and reduction in patient anxiety, inconvenience, and discomfort, the savings are even greater (National Eye Institute, 1983).

A review of the literature reveals limited information on the economic and social costs of cataracts. Information is available for many medical costs of treating cataracts, which are used to cross check the valability of the survey results. Work loss estimates are available only for all visual disorders in aggregate. No estimates for other direct costs or indirect costs, such as restrictions in activities, anxiety, or caregiving, are available. Due to the nature of senile cataracts, which are incident predominantly upon the elderly, most medical costs are covered by Medicare, and work loss is substantially reduced in importance relative to other illnesses. As a result, a substantial portion of the direct costs associated with cataracts are incurred by society at large, rather than by the affected individual.

1. Dr. Fukui, Director of the National Eye Institute, was unable to provide further documentation on how this figure was derived.

4.2 MEDICAL COSTS

A survey of the direct medical costs revealed large variations in charges for similar treatments across geographical regions (U.S. Congress, 1985). For the broader economic measures of cost, estimates were found for aggregate visual disorders, but not for cataracts alone. NEI sponsored research by Hu (1982) gives a comprehensive breakdown of economic costs for all visual disorders in a human capital framework. Costs are given in 1972 and 1981 dollars, but estimates on the various cost components come from different years depending on the source. Cataracts accounted for approximately one-third of all visual disorders in 1981, but we don't know how costs are distributed across eye diseases. However, the figures do give some indication of the orders of magnitude. In the medical literature, one study gives a breakdown of the medical costs based on a survey of 124 ophthalmologists (Balyeat, 1985), and a Danish study estimates the economic benefits to society of cataract surgery (Bernth-Peterson, 1982). Most of these estimates are out of date, and none are comprehensive for cataracts alone. Table 4-1 presents a summary of the cost components and currently available cost estimates for cataracts.

To systematize the review of medical costs, it is helpful to divide them into categories according to phase of treatment. The three phases consist of: pre-surgery, surgery, and post-surgery. The medical cost categories and treatments are summarized in Table 4-2.

4.2.1 Pre-surgery Phase

The pre-surgery phase of treatment consists of prevention and diagnosis. As noted in Chapter 2, there is no known medical preventative treatment for cataracts. In the case of risk from UV exposure, however, it has been strongly recommended that sunshields (hats or umbrellas) or sunglasses which absorb ultraviolet rays be used (Waxler 1986a, p. 23). This could be considered a preventative cost, although the degree of health risk avoided is unknown, as is the percent of cost attributable to the reduction of health risk. Though interesting, this information does not provide a measure of health risk value.

Table 4-1

Summary of Currently Available Damage Estimates Associated With Cataracts*

<u>Category</u>	<u>Quantified</u>		<u>Unquantified</u>
	<u>For Cataracts</u>	<u>For Aggregate Visual Disorders Only</u>	
<u>Medical</u>			
Pre-Surgery			X
Surgery	X ¹		
Post-Surgery			X
<u>Work Loss</u>			
Holding Job (time lost)		X ²	
Holding Job (reduced productivity/wage)			X
Not Working (early retirement)		X ³	
<u>Other Out-of-Pocket Expenses</u>			
Hired help for chores, etc.			X
<u>Indirect</u>			
Restricted Activities (chores, leisure)		X ⁴	
Discomfort		X ⁴	
Unpaid Caregiving			X ⁵

* Not all damages are measured in dollars.

X Indicates whether information for the damage category is quantified for cataracts, quantified for all visual disorders only, or is not quantified.

¹ See Table 4-4

² Hu (1982, p. 23)

³ Bernth-Peterson, 1982. (Report of occupational, social and economic outcomes of cataract surgery on 123 patients in Denmark. Comparison is made of cost of surgery and community benefits, defined as saved disability pension payments, public health care, and nursing home accommodation.)

⁴ NCHS data. See Table 4-5

⁵ Estimates have been made for some disabilities, but not eye disorders.

Table 4-2
Outline of Medical Costs Associated with Cataracts

Treatment Phase	Comments
1. Pre-Surgery	
<ul style="list-style-type: none"> o Preventative measures o Physician visits o Change eyeglass lens or contact lens prescription o Second diagnostic opinion 	<p>Protective sunshields or UV-absorbing sunglasses</p> <p>Average length of time of pre-surgery phase and percentage increase in physician visits and prescription changes due to cataracts are not known.</p>
2. Surgery	<p>Most of this cost is covered by Medicare for older patients.</p>
<ul style="list-style-type: none"> o Eye Exam o Physical Exam o Facility Fee o Surgery Fee o Anesthesiologist's Fee o Prosthetic 	<p>Facility and surgery fee vary depending inpatient or outpatient setting</p> <p>IOL, contacts, eyeglasses</p>
3. Post-surgery	
<p>A) Immediate Post-surgery</p> <ul style="list-style-type: none"> o medical sundries such as eyedrops and medication 	<p>Frequent check-ups are necessary the first six weeks after surgery; the cost of this care is usually included in the surgery fee.</p>
<p>B) Late Post-surgery</p> <ul style="list-style-type: none"> o Treatment for complications such as after-cataract or retinal detachment o lens implantation as a secondary procedure 	<p>Most patients experience minimal post-surgical complications</p>

Diagnosis involves a visit to an optometrist and a referral to an ophthalmologist. Due to the slow rate of progression of the disease, the cataract will mature for many years from the time it is first detected until eyesight has deteriorated sufficiently to warrant surgery. The costs incurred by an individual will include paying for more visits to an optometrist for eye checkups and more frequent replacement of eyeglasses or contact lenses as the prescription changes. Some of these costs would be incurred anyway, as part of a general health maintenance routine; it is difficult to estimate from the literature what portion of these costs can be attributed to cataracts. Expenditures for physicians' services for treatment of cataracts are presented in Table 4-3.

Diagnosis is straightforward, so there should be no need for a second opinion, unless it is required for insurance purposes. However, there have been cases of surgery performed for cataracts when there was no reduction in visual acuity. It has been estimated that 23 to 36 percent of all cataract surgery may be unnecessary (U.S Congress, 1985, p. 276). Thus, a second opinion is sometimes required to minimize the chances of this occurring.

4.2.2 Surgery Phase

As discussed in Chapter 2, the only effective medical treatment is surgery, either on an inpatient basis at a hospital, or on an outpatient basis at a hospital, ambulatory surgery center (ASC) or doctor's office. Since at the present time the great majority of people who have surgery are 65 years or older, costs are often covered by Medicare.² An example of Medicare coverage for surgery in an ASC is given in Table 4-4.

2. The amount Medicare will pay is determined by several factors, the first of which is whether or not the surgery is performed on an inpatient or outpatient basis. Payment will also vary by geographic region, by doctor, and by the kind of agreement the surgeon has entered into with Medicare. There are currently two bills before the Congress to control the medical costs of cataract surgery to the government as a result of hearings held last year before the House Committee on Aging investigating fraud, waste and abuse in cataract surgery. One bill is concerned with limiting payments for surgery fees under Part A of Medicare (HR 5300) and the other is concerned with limiting payments for outpatient facility fees under Part B of Medicare (HR 3061).

Table 4-3
Expenditures for Physicians' Services for
Treatment of Cataracts in the United States*
(in 1,000's of visits and in 1,000's of 1981 dollars)¹

	Total Visits	Total Cost Of Visits	First visit			Follow-up Visits		
			No. of First Visits ²	Cost per Visit ³	Total cost of First Visits	No. of Other Visits ²	Cost per Visit ³	Total Cost of other Visits
Ophthalmologists	2,223	\$69,149	756	\$40.22	\$30,406	1,467	\$26.41	\$38,743
Other MDs	<u>250</u>	<u>6,676</u>	<u>85</u>	38.79	<u>3,297</u>	<u>165</u>	20.48	<u>3,374</u>
Total:	2,473	\$75,825	841		\$33,703	1,632		\$42,117

* Source: Hu, 1982, pp. 26-27.

¹ Estimates from National Ambulatory Medical Care Survey, 1977, unpublished data.

² Based on the proportion reported in the National Disease and Therapeutic Index, 1980, IMS International, Inc.

³ Based on the American Medical Association Physician Survey, 1981.

Table 4-4
**Medicare Payment for Cataract Surgery
in an Ambulatory Surgery Center***

Service	Fee	Medicare Coverage	Patient Liability
Comprehensive Eye Exam (Two parts)	\$ 37.80 9.60	80% -0-	7.56 9.60
Tests for Corneal Health:			
Clinical Specular Endothelial Microscopy--Both eyes	50.00	-0-	50.00
Ophthalmic Biometry/A-Mode Ultrasound, w/IOL Calculations	140.00	80%	25.20
Extracapsular Cataract Extraction with IOL Implant	2,160.00	100%	0.00
Intraocular Lens	400.00	80%	80.00
Anesthesiologist (Approx.)	480.00	100%	0.00
Facility Fee	<u>637.50</u>	100%	<u>0.00</u>
TOTAL:	\$3,915.50		172.36

* Based on a sample invoice from Boulder Valley Eye Clinic (1986), for extra-capsular cataract extraction with implant on one eye. If the second eye is done, only the \$80 IOL charge is incurred by the patient.

The bottom line is that the Medicare rules affect how much of the cost of surgery individuals pay directly. It is estimated that the average cost of cataract surgery and visual rehabilitation was \$2500 in 1981 (National Eye Institute, p. 99), but most individuals pay only a fraction of this figure. This may affect individuals' behavior toward treatment of the disease, e.g. whether or not to have surgery, or how long to delay it. A broader issue is the way the government spends its tax revenues; the rules affect the incentive structure in the health care industry and in the IOL manufacturing industry. This will ultimately influence how many operations are performed and under which setting.

At present, Medicare allowances are as follows:

- o **Hospital Inpatient.** Under the prospective payment plan of Medicare, Part A, cataract surgery has been assigned to diagnostic related group (DRG) 39. Under DRG 39, hospitals receive from Medicare roughly \$1200 (plus or minus \$300 for regional differences) for facility fees incurred during cataract surgery. The hospital receives the same amount whether an IOL is implanted or not (U.S. Congress, 1985, p. 246).
- o **Hospital Outpatient.** When cataract surgery with lens implantation is performed on a hospital outpatient basis, the facility is reimbursed by Medicare part B on a cost basis at 80 percent of reasonable cost. Reasonable cost is defined to be the lower of (1) the actual cost or (2) the customary or prevailing charge. The customary charge is based on an array over time, and the prevailing charge is based on an array over the geographical area. In addition, the outpatient center is allowed to pass on to Medicare the cost of the IOL, an item which is included in the DRG payment for the inpatient procedure. A survey of actual invoices revealed charges ranging from \$1684 to \$4570 (1985 dollars) (U.S. Congress, 1985, p. 248).
- o **Ambulatory Surgical Centers (ASC).** These are surgical centers which are usually designed specifically for cataract and other eye

disease procedures, and are shared by a group of physicians. Medicare pays some maximum amount (\$553 in 1985) in facility fees plus the cost of the lens. The beneficiary is required to pay 20 percent of the cost of the IOL. The charges to Medicare for lenses are comparable to the outpatient cost, ranging from \$300 to over \$900 (1985 dollars).

The concern in Congress is that the cost of surgery should be less for procedures performed on an outpatient basis since fewer resources are used, but due to the current reimbursement practices they are not. Inpatient procedure reimbursements are controlled by the new DRG system, but no new constraints have been set in place to control payments for procedures performed on an outpatient basis (personal conversation with Ken Marsalek of the Health Care Financing Administration, 9/2/86).

There are factors other than cost that may influence the setting in which surgery takes place. For elderly patients, patients with poor or absent vision in the opposite eye, or those with significant medical problems, hospitalization may be warranted or preferred (Leisegang, 1985, p. 629).

4.2.3 Post-surgery Phase

Care of the patient immediately following a cataract removal, i.e. during the first six weeks, is usually minimal. The patient should avoid bumping or injuring the operated eye, and a protective patch must be worn over the eye, but otherwise, normal activities may be resumed. The patient must be examined at regular intervals by the ophthalmologist and must be able to report readily if problems arise (Leisegang, 1984, p. 629). The cost of immediate post-operative care is generally included in the surgery fee.

If after-cataract develops, additional surgery is needed to remove the opacification of the remaining lens tissue. After-cataracts may develop in as many as 60 percent of anterior chamber lens patients, and will usually show up

within six months of the initial surgery. This additional procedure costs \$500 to \$700 (personal conversation with David Karchan, Executive Director of the American Society of Cataracts and Refractive Surgery, September 2, 1986).

The implant of an IOL is sometimes performed as a secondary procedure. Secondary surgery is performed when the initial surgery did not include an IOL implant. No data are available on the percent of cases, although 1984 data from manufacturers suggests that approximately 10 to 20 percent of anterior chamber lenses and 1 to 3 percent of posterior chamber lenses were implanted secondarily (Stark, 1984). However, the percentage is most likely declining, since the use of IOLs at the time of extraction is increasing.

Further post-operative costs will be incurred if complications develop. Complications can range in severity from minor irritation due to intolerance of the IOL by the eye to complete loss of eyesight in rare cases. (A thorough discussion of complications can be found in Leisegang, 1985, pp. 626-629.)

Other medical costs include drugs and sundries, e.g. eye drops and pain medication. Expenditures for rehabilitation services and equipment would be incurred for the small percentage of cases which result in blindness, due to complications resulting from surgery or the IOL. Institutionalization may be necessary for the elderly or the blind. Hu (1982, p. 23) estimated these costs for all visual disorders (expenditures from various years quoted in 1981 dollars).

4.3 WORK LOSS COSTS

Cataracts can cause decreased productivity at work, days missed or inability to hold a job as vision deteriorates, or as time is spent away from work in visits to medical professionals. This is a cost to society as productivity is lost. For the individual the cost may take the form of lost wages or a lower wage than otherwise would have been obtained, as a result of diminished performance. Some studies also include restricted ability to perform household chores in this category, while others consider this an indirect cost.

Available estimates of decreased productivity or income lost due to cataracts alone only partially address these damages for limited population groups and are of limited use in this assessment (Hu 1982, Bernth-Peterson 1982). Data collected in the 1977 National Health Interview Survey are published by the National Center for Health Statistics (NCHS) on restricted activity days, bed disability days, physician visits, and frequency of bother, but are reported for the aggregate of all visual impairments. Cataracts account for nearly one third of all visual impairments, so crude estimates of the magnitudes can be inferred. Hu (1982, p. 23) reports cost estimates for aggregate visual disorders in 1972 and 1981 dollars for loss of earnings due to days lost from work and inability to work and loss of economic value for females unable to keep house. Days lost from work due to all visual disorders caused a loss of about \$110 million in 1981, inability to work due to all visual disorders caused a loss of about \$4,600 million, inability of homemakers to keep house due to all visual disorders caused a loss of \$970 million. We can expect that work loss due to cataracts will become a more significant component of the COI measure if incidence shifts to younger people.

4.4 OTHER DIRECT COSTS

COI and other direct cost measures of health effects sometimes include out-of-pocket expenses incurred as a result of the illness other than medical expenditures and work loss. These include the cost of hired help for household chores, transportation or self-care. No attempt to measure these costs was found in the literature.

4.5 INDIRECT COSTS AND CAREGIVING

The indirect costs of cataracts encompass restrictions in leisure and recreational activities, restricted ability to perform household chores, time costs of waiting for eye care, the value of unpaid caregiving by friends and family, and patient anxiety and discomfort. Cataract is one of the most common and widely feared eye diseases. According to one source, "the surgery may well be dreaded by the patient, who must often wait and suffer deterioration of

vision for many years after the first hint that a cataract is developing" (van Heyningen, 1975, p. 70).

By their nature indirect costs are often difficult to quantify. Market values can be obtained for some, such as the cost of hiring someone to help with household chores and transportation. Other costs are derived from opportunity cost measures, such as caregiver services performed by a family member who would otherwise be working. No attempts to measure these costs for cataracts were found in the literature. Estimates for work loss, restricted activity days, bed days, and frequency of bother in 1977 are published by NCHS for all visual disorders. These figures are summarized in Table 4-5. Hu (1982, p. 23) estimates an indirect cost of \$440 million for institutionalized persons and \$76 million for waiting time for eye care for all visual disorders in 1981 (1982 dollars).

The value of unpaid care provided by family members and friends of elderly, disabled or ill people has recently received attention in the literature (see also Appendix D for additional analysis on the Value of unpaid caregiving). Caregiving is usually referred to as the voluntary services provided to dependent and/or disabled persons. It is considered different from child care, although the time costs may be similar. The caregiver is usually a close family member (son, daughter, or daughter-in-law), but may be unrelated. Caregiving covers a wide range of activities, depending on the kind and degree of disability. Some individuals require total care around the clock, and others simply need transportation services or assistance with minor chores.

In the case of cataracts, some caregiving is likely to be necessary in the pre-surgery stages of the disease when deterioration of vision has begun to progress. Caregiving will also be a factor for patients who decide against surgery because of other health problems or for other reasons (in which case the cost would not be completely attributable to cataracts) and those patients for whom surgery results in vision-disabling complications.

Like the value of homemakers' services, voluntary care is not calculated in the Gross National Product, but is a cost to society nonetheless. Time allocated to caregiving is time not allocated to some other activity, whether it be work or

Table 4-5

Work Loss, Restricted Activity Days, Bed Days, Physician Visits
and Frequency of Bother For
Visual Impairments, Reported in Health Interviews
United States, 1977^{*}

	All Visual Impairments			Severe Visual Impairments			Other Visual Impairments		
	Number in thousands	Rate Per 1,000 persons	Percent distribution	Number in thousands	Rate Per 1,000 persons	Percent distribution	Number in thousands	Rate Per 1,000 persons	Percent distribution
Visual Impairments¹									
All Causes	11,415	53.8	100.0	1,391	6.6	100.0	10,024	47.2	100.0
Cataract	3,274	15.4	28.7	495	2.3	35.6	2,779	13.1	27.7
Percent of Conditions² (All visual disorders)									
Causing Limitation of Activity			13.1			37.0			9.8
With > 1 bed day in past year			3.3			5.3			3.0
With > 1 physician visit in past year			43.4			47.5			42.8
Disability Days² (All visual disorders)									
Work Loss Days per year	.3			--			.3		
Restricted Activity days per year	6.8			23.1			4.5		
Bed Days per year	1.3			5.5			.8		
Frequency of Bother³ (All visual disorders)									
All the time			27.7			67.9			22.1
Often			6.1			8.1			5.8
Once in a while			18.1			9.1			19.4
Not Bothered			26.4			7.4			29.0
Unknown			21.7			7.6			23.7

^{*}

¹ National Center For Health Statistics, 1977. Prevalence of Selected Impairments: series 10, No. 134.

² Table E, p. 9

³ Table F, p. 9
Table J, p. 11

Leisure. In most studies, some form of market valuation is used to estimate the cost of caregiving. In some studies, the time allocated to caregiving has been evaluated using time diaries (e.g., Nissel, 1984). The market value for comparable formal care or the minimum wage (sometimes adjusted for labor force participation rates) are then combined with the time allocations to derive a value for the care. From an economic perspective, the opportunity cost of the value of the caregiver's next best time use may be a better measure. The market value for comparable services may be an under- or overestimate of the true opportunity cost of the caregiver's time. Furthermore, none of these measures account for the psychological costs incurred by both the caregiver and the recipient. These costs may be positive or negative.

No studies of the cost of time devoted to caregiving for individuals with cataracts have been identified. A summary of costs estimated for informal caregiving of elderly people with a variety of disabilities is presented in Table 4-6 (Rivlin et al. forthcoming). The existing studies are helpful in that they enumerate the kinds and degrees of caregiving required for various illnesses and disabilities, and provide crude estimates of the average cost of providing care. For cataract patients, these estimates can be improved upon by using opportunity costs in place of average costs and including the value of other forgone activities on the part of the giver, and by breaking down the estimates by severity of disability and age. Another factor to consider is the changing nature of the technology of cataract treatment. If surgery continues to be performed on younger patients at less advanced stages of the disease this could have an impact on caregiving needs in the pre-surgery phase (less care needed) and in later years if complications result from wearing IOLs longer (more care needed).

Table 4-6
Cost Estimates of Informal Caregiving*

Informal Care Study	Monthly Cost Estimate
<u>Paringer</u> (1983) using Manitoba Longitudinal Study on Aging and the Health Interview Survey (caregivers living with dependent elderly person)	\$967 ¹ , \$403 ²
<u>Nissel</u> (1984) using small sample from Oxfordshire, England (family care of live-in elderly handicapped relatives)	291 pounds ³
<u>GAO</u> (1977) using Cleveland, Ohio sample (services used by the dependent elderly to stay at home)	\$287 ⁴ , \$673 ⁵
<u>Gurland</u> (1978) using New York City sample (family care of the severely disabled)	\$303 ⁶
<u>Maryland State Office on Aging</u> (1982)	\$968 ⁷
<u>Doty</u> (1986) using Horowitz and Dubrof (1982) New York City sample (time cost of adult children helping disabled parents)	\$250 ⁸
<u>Doty</u> (1986) using National Survey of Informal Caregivers (DHHS, 1985b) (time cost of informal caregivers to the elderly disabled)	\$308 ⁹

- * Source : Rivlin et al., forthcoming.
- 1 Personal care dependent, not adjusted for labor force participation.
- 2 Personal care dependent, adjusted for labor force participation.
- 3 Handicapped, shared living arrangement, valued at similar skills.
- 4 Greatly impaired, market value of formal care.
- 5 Extremely Impaired, market value of formal care.
- 6 Dependent, labor market value at skill level of activity.
- 7 Severely impaired, minimum wage.
- 8 All Impairments, minimum wage.
- 9 Two-thirds of ADL caregivers, minimum wage.

5.0 DESIGN AND APPLICATION OF THE CATARACT PATIENT SURVEY

5.1 INTRODUCTION

A telephone survey of 66 cataract patients in the Denver metropolitan area was conducted. As identified in Section 3.5, the primary objectives were to:

- o Obtain data to verify and improve Cost of Illness (COI) measures of economic damage for both the individual and society.
- o Understand the impacts of cataracts and measure the total value of damage through ranking and WTP approaches.

Some of the results must be viewed as preliminary in nature due to the relatively small sample size, that some of the analytic approaches have not previously been employed, and that the values are generated with individuals ex post of incurring an illness **(see Section 3.5.2)**.

A separate survey of 11 Metro-Denver area ophthalmologists was also conducted to obtain characteristics about the cataractous population as a whole, to examine the representativeness of the valuation survey sample and to provide initial data to illustrate the application of the valuation results to valuing changes in UV-B (See Chapter 7).

In general, design of the survey instrument and its implementation followed the procedures in Dillman (1979), and followed previous applications to valuing health impacts in Rowe and Chestnut (1985) and Chestnut et al. (1987).

5.2 CATARACT PATIENT SURVEY PROCEDURES

5.2.1 Enlistment and Qualification

Cataract patients were enlisted to participate through the cooperation of six Denver area ophthalmologists. During the month of October, 1986, the

ophthalmologists were provided with letters about the study to mail to a specific subgroup of their patients. The patient letter explained the purpose and conduct of the study, and asked the respondent to either phone or return a card indicating their willingness to be contacted about the study. Approximately 50 percent of those individuals receiving the information letter responded with interest in participating.

Respondents who agreed to participate in the study were asked a few short qualifying questions. To qualify, they had to currently have cataracts or have had them within the last two years. Questions were also asked to insure that the sample covered a range of age, sex and cataract status groups. Upon qualification, a time for the telephone interview was arranged. In advance of the interview, the respondent was mailed a letter confirming interview time, and outlining two of the survey questions (Ranking Questions 1 and 3) and the response categories for the income questions. (This advance information was referred to as the "pink sheet" in the questionnaire.)

A concern arose that by working through ophthalmologists the enlistment might not be reaching those who, for one reason or another, were not seeking treatment for their cataracts. Therefore, contacts were made with local senior center case workers to identify the potential magnitude of this deficiency. Case workers in the Denver area identified that the number of individuals (without other complications) who do not eventually seek treatment was quite low due to the low costs (many clinics offer no-cost arrangements to seniors on Medicare), ease of treatment, and the efforts of case workers to reduce fears about surgery. Nevertheless, the sample may still underrepresent a small group of individuals who do not treat their cataracts. One patient was enlisted through contact with senior center case workers.

5.2.2 Pretest

During the enlistment process the survey was designed, reviewed, pretested and revised, and a survey team trained. The survey design is discussed in Section 5.3. The pretest survey instrument was reviewed by economists, epidemiologists and ophthalmologists. The survey was pretested with 6 patients during the week of November 17, 1986.

5.2.3 Full Survey

The full survey was conducted during the period November 22, 1986 to December 26, 1986. Each of the 66 patients with whom an interview was arranged was contacted by telephone. Sixty-five patients completed the entire survey; one patient discontinued the interview after the first ranking question. A summary of the age, sex and cataract status of the sample population is found in Table 5-1. The representativeness of the sample to the cataractous population as a whole is addressed in Chapter 6.

5.3 CATARACT PATIENT SURVEY INSTRUMENT DESIGN

5.3.1 Overview

The survey instrument is found in Appendix A. Three variations on the instrument questions were designed:

- o Version A, for those individuals who have not yet had surgery.
- o Version B, for those individuals who have had surgery on one eye and anticipate having surgery on the other eye.
- o Version C, for those individuals who have had surgery on one or both eyes and anticipate no further surgery, unless post-surgical complications arise.

The survey instrument was designed to collect data on the individual damage categories, rank the importance of the different categories, ask total value WTP questions and conclude with socio-demographics. The general flow follows that used in Rowe and Chestnut (1985) and Chestnut et al. (1987). The objectives of this flow, in addition to collecting data on relevant variables, is to have the respondent work through the damage categories and the impacts of the health effects to their well-being prior to ranking the effects and providing total WTP values. In addition, the design allows consistency checks to be built into the

Table 5-1
Number of Survey Respondents by Subgroup¹

Group		A		B	C	All		
		(Pre	Surgery)	(Between	(Post	Respondents		
		Surgery)		Surgery)	Surgery)			
Number Of Eyes With Cataracts		1	2	2	1	2	1	2
		3	4	20	12	27	15	51
Age	Sex							
<55 years	Male	0	0	2	4	4	4	6
	Female	1	0	2	2	4	3	6
55-64	Male	0	1	5	1	7	1	13
	Female	1	0	4	1	6	2	10
65-74	Male	0	0	2	1	2	1	4
	Female	1	1	0	1	2	2	3
>75	Male	0	0	2	1	1	0	3
	Female	0	2	3	2	1	2	6
All Ages	Male	0	1	11	0	14	6	26
	Female	3	3	9	6	13	9	25

¹ 66 Total Respondents

survey to examine the validity of the WTP responses. The data collected in the early sections also allow calculation of comprehensive COI damage measures.

Below, the primary design objectives of the individual sections of the survey instrument are discussed. Statistical results are summarized in Chapter 6.

I. Introduction and Current Status Questions

This section verified and gathered general information about the respondent's current cataract status and existing vision problems. The existence of complicating eye or general health conditions was also identified. Most importantly, this section allowed the respondent time to become comfortable with the interviewer and the interview process prior to the probing questions in subsequent sections. The interviewer also learned whether the respondent had reviewed the information sheet prior to the interview. Over 95 percent of the respondents had reviewed the sheet prior to the survey.

II. Medical Costs

This section addresses the past, present and anticipated medical treatment and costs. The information in this section allows one to calculate the full medical cost component, for both the individual and society, of a COI measure. Included are:

- o Insurance coverage and deductibles.
- o Doctors' fees for incremental office visits, driving costs for doctor's office visits, surgery procedure and location, surgery costs, incremental costs for glasses, and other medical expenses.

III. Work Loss

The work loss section covers earnings lost due to:

- o Change in employment including changing jobs, reducing the number of hours worked, quitting, or retiring.

- o Lost wages or sick leave due to treating the illness or to having surgery.
- o The value of lost earnings.
- o Reduced productivity and enjoyment at work due to cataracts.
- o Effects on volunteer work.

IV. Chores and Leisure

This section addresses the impacts of cataracts upon paid and unpaid caregiving provided to the affected individual, the effects of cataracts on leisure activities, and any other expenditures incurred related to having cataracts.

V. Rankings and WTP Valuations

This section pulls together the various impacts of cataracts through a ranking, and examines alternative approaches to estimating the total value of the impacts actually experienced. As discussed in Chapter 3, the total value of adverse health effects may substantially exceed the out-of-pocket medical costs and work loss incurred due to the impacts on the ability to do and enjoy desired activities, discomfort, and other factors. The purpose of this section is to measure the total value of all impacts of cataracts, including the out-of-pocket expenses.

The questions in this section focus upon actual impacts experienced, i.e., the damages that would have been avoided if cataracts had not developed. Considerable care in design and pretesting was undertaken to insure the respondents were not valuing what might have happened if they did not treat their cataracts. However, concern about what might happen, even if it did not happen, is an adverse impact actually experienced and is included in the valuation.

Several questions in this section are also designed to provide alternative total value measures that are expected to provide collaborating evidence.

Question 1 of Section V was provided to the respondent by mail prior to the interview. It asks for a ranking of the various impacts on a 3 point scale. If the impacts that rank higher (more adverse) than medical costs incurred by the individual are also valued higher, then the total value of the impacts is at a minimum equal to a multiple of the medical costs incurred by the individual, where the multiple is determined by the number of items ranked greater than or equal to medical costs. Thus, one possible measure of total value is defined as:

$$\text{RANKVAL} = \text{MEDHH} * (\text{GTMED} + \text{ETMED})$$

where:

RANKVAL = a value measure based solely upon the rankings in Question 1

MEDHH = the medical costs incurred by the household

ETMED = the number of categories ranked equal to MEDHH

GTMED = the number of categories ranked more adverse than MEDHH

Because this measure assumes all categories ranked higher than MEDHH have an equal value to MEDHH, and that all categories ranked less than MEDHH have zero value, the RANKVAL estimate is expected to be a lower bound on total value. RANKVAL will have additional inaccuracy added due to measurement error on MEDHH and due to inaccuracy in ranking the damage categories.

Question 3 of Section V was also provided to the respondent prior to the interview. It asks what percent of the total actual or expected adverse impacts of cataracts are attributable to medical costs incurred by the household. Using this information an alternative value measure can be derived as:

$$\text{PIEVAL} = 100/\text{PIE} * \text{MEDHH}$$

where:

PIEVAL = a value measure based upon the MEDHH and response to
Question 2

PIE = the percent of total adverse impacts accounted for by MEDHH

The expected value of PIEVAL should equal the total value of all cataract impacts, but may have substantial variation due to measurement error in the estimates of MEDHH and PIE.

Question 4 uses the PIE response and the MEDHH estimate as a starting point in a two-iteration ex post valuation (see Chapter 3.5) willingness-to-pay sequence. The question addresses the maximum amount the individual would have been better off paying rather than having incurred the adverse impacts of cataracts. The response to this question yields another value measure, MWTP2.

MWTP2 = maximum WTP stated in question 4

Due to the unusual nature of this question (as an ex post valuation) and the frequent comments provided by the respondents at this stage, the interviewer also rated the responses in terms of the respondent's apparent understanding of the question, and whether the respondent's comments suggested the final reported amount was probably substantially less than or greater than their actual value of the impacts, or if it was in the "ball park."

The expected value of this measure is the total value of cataract impacts. The problem of starting bids providing information that may bias responses away from true underlying values (Rowe and Chestnut, 1983) is addressed through the use of values approximating PIEVAL as the starting point. As PIEVAL is based upon information provided by the respondent, no external information contaminates the valuation exercise. Measurement error is expected in the MWPT2 value due to limited ability of the respondents to precisely determine their total value of cataract impacts.

Question 5, as a final cross check on total value estimation, addresses the ranking of MEDHH if the household had to pay the full medical costs of their surgery. Based upon the reranking, another value measure was defined:

$$\text{FULLVAL} = \text{TSCOST2} * (\text{GTFULL} + \text{ETFULL})$$

where:

FULLVAL = a value measure based upon question 5

TSCOST2 = the full medical cost for surgery the household would have had to pay if they paid all expenses.

GTFULL = the number of damage categories ranked higher than TSCOST2

ETFULL = the number of damage categories ranked equal to TSCOST2

VI. Socio-Demographics

Standard socio-demographic information on age, sex, marital status, home ownership, education and income was collected.

5.3.2 Consistency Checks

The survey instrument is designed to identify inconsistency between the sections addressing individual damage categories and the total damage ranking and valuation. For example, one would expect those who incurred higher medical costs, higher work loss or higher leisure impacts to rank those categories as more important than those without these impacts. Consistency would also require that PIE, the percent of the total impacts accounted for by MEDHH, be highly correlated to the amount and ranking of MEDHH. If the assumption that the rankings are ordinally correlated with the value of the impacts is correct, then there should be a high correlation between the ranking for MEDHH and the amount of MEDHH, the PIE value and the MWTP2 response. These expectations are generally fulfilled. For a summary of consistency checks, see Appendix D.

6.0 CATARACT PATIENT SURVEY RESULTS

Throughout this chapter results are presented separately for individuals in Group A (pre-surgery phase), Group B (between surgery phase where both eyes are operated on), Group C (post-surgery phase) and for all respondents in the survey. In some instances the measure of impacts of cataracts is best represented by the summation of impacts for individuals in different phases of cataracts. Adjusted variables representing this are also presented based upon the sample as a whole. For example, medical costs are best represented as the sum of pre-surgery, surgery and post-surgical phases for those who undergo surgery.

6.1 CATARACT PATIENT SURVEY - INTRODUCTORY QUESTIONS AND CURRENT STATUS

The survey was conducted with 66 patients (Table 5-1) with 65 completing the survey and one terminating after ranking question 3. The average time to complete the survey was 34 minutes. Over 95 percent of the respondents had reviewed the advance information page mailed prior to the interview.

In some respects, the sample misrepresents the cataractous population as a whole. For example, the sample under-represents those over 65, and under-represents those whose cataracts do not warrant surgery, or those whose cataracts warrant surgery but do not undertake surgery. The representativeness of the sample is further discussed in Section 6.6. The implications of potential misrepresentations are noted in the discussion of the results.

Table 6-1 summarizes the average time elapsed since cataracts were first diagnosed, the percent of patients currently experiencing different adverse symptoms in one or both eyes, and the percent of patients with other confounding eye and medical problems. Cataracts were first diagnosed for most respondents within the past 5 years. Samplewide, about 67 percent are currently experiencing some symptoms associated with cataracts, however, the current symptom rate is significantly reduced for those in the post-surgery phase.

Table 6-1
Sample Characteristics Concerning Cataract Condition¹

Group	A (Pre-Surgery)	B (Between Surgery)	C (Post- Surgery)	All Respondents
1. Number of Observations	7 (10.6%)	20 (30.3%)	39 (59.1%)	66 (100%)
2. % First Diagnosed				
a. <1 year ago	33	30	10	18
b. 1-2 years ago	17	35	36	34
c. 3-5 years ago	33	30	33	32
d. 6-10 years ago	17	5	13	11
e. >10 years ago	0	0	8	5
3. % With Symptoms	100	90	49	67
a. Problems seeing clearly straight ahead	29	40	8	20
b. Problems with side vision	0	20	5	9
c. Problems seeing at night	71	40	10	26
d. Sensitive to bright light during the day	29	50	13	26
e. Double vision	43	20	0	11
f. Haziness or film over the eye or after-cataracts	57	45	23	33
g. Unstable Vision	0	10	13	11
h. Irritation due to IOL, glasses or contacts	--	10	10	10
i. Other Symptoms	57	45	23	33
4. % With Other Eye Problems	14	10	15	14
5. % With Other Medical Problems	0	15	15	14

¹ Percentages reported are adjusted for missing values.

The most significant current symptoms for those in Groups A and B are problems seeing straight ahead, problems seeing at night, problems with light and problems with haziness or film over the eye. Those in Group C indicate similar problems, but at a reduced rate. Post-surgical problems of unstable vision and irritation due to implants, glasses and contacts were each mentioned by just over 10 percent of the respondents. Symptoms in the "Other Symptoms" category included poor depth perception, problems focusing, problems with glare from snow during the day and wet streets at night, and a color differential in the eye with the cataract.

Table 6-2 summarizes the characteristics of medical treatment, and confirms the trend of performing surgery on an out-patient basis, either at hospitals or at ASCs, and the predominant use of IOL implants to correct vision following surgery.

6.2 CATARACT PATIENT SURVEY - MEDICAL COSTS

Medical expenses related to cataracts are summarized in Table 6-3. The expenses are presented separately for those incurred by the affected individual and those paid by society as a whole. Over 95 percent of the respondents had medical insurance or other programs that payed part or all of their expenses. The average percent coverages were 81 percent for doctors' expenses, 84 percent for hospital services, 35 percent for glasses and 74 percent for prescription medications.

Table 6-3 presents expenses by category. The costs for the individual and the total costs are based upon the estimates provided by the individual and the individual's insurance coverage rates. Additional doctor visits were calculated as those in the past year not included in the surgery fee beyond those that normally would have occurred if cataracts had not developed. Evidence from the Ophthalmologist survey (Section 7.3-7.4) and the wording of the question suggest this damage may be somewhat understated. Additional driving costs were calculated based upon the number of trips to the doctor's office in the past year. Additional eyeglasses prescription costs were also calculated based upon costs in the last year. Surgical expenses were based upon the actual or

Table 6-2
Medical Treatment Characteristics¹

Group	A (Pre-Surgery)	B (Between Surgery)	C (Post- Surgery)	All Respondents
Number of Observations	7	20	39	66
1. Surgery Location ²	(Expected)	(Actual & Expected)	(Actual)	(Actual & Expected)
% Hospital Inpatient	0%	15%	8%	10%
% Hospital Outpatient	50	40	39	39
% ASC	50	40	51	48
% Doctor's Office	0	5	3	3
2. Time Since First Surgery				
% < 6 months	--	50	26	34
% 7-12 months	--	25	23	24
% 1-2 years	--	15	39	32
% 2-5 Years	--	10	10	10
% > 5 Years	--	0	3	2
3. % Having Follow-Up Surgery	--	15	36	29
4. Visual ₃ Correction After Surgery				
% IOL	--	85	72	76
% Cataract Eyeglasses	--	10	3	5
% Contact Lenses	--	10	13	12

¹ Percentages adjusted for missing values (question not applicable or response of "don't know").

² If both eyes have had surgery, location for the most recent surgery is reported.

³ Categories are not mutually exclusive.

Table 6-3
Summary of Additional Medical Expenses Due to Cataracts¹
 (Mean With Standard Error of the Mean in Parentheses)
 I. Paid By The Household

Group	A (Pre-Surgery)	B (Between Surgery)	C (Post- Surgery)	All Respondents
Number of Observations	7	20	39	66
<u>COST CATEGORY</u>				
1. Additional Doctor visits	\$28 (14)	\$38 (14)	\$18 (5)	\$25 (5)
2. Driving Costs	22 (9)	59 (30)	43 (16)	46 (13)
3. Changes in Eyeglasses Prescription	41 (27)	72 (13)	11 (4)	33 (6)
4. Surgical Expenses (actual and near-term expected)				
a. One Eye Only	533 (219) n=3	--	422 (207) n=12	444 (169) n=15
b. Both Eyes	550 (87) n=4	920 (268) n=20	933 (233) n=27	872 (162) n=51
5. Follow-up Surgery Expenses (for those with this expense) ²	-- --	523 -- n=3	695 (65) n=14	665 (56) n=17
6. Other Medical Expenses (for those who have had them)	-- --	135 (129) n=5	107 (24) n=9	117 (46) n=14
7. Total	432 n=7	1201 n=20	1116 n=39	849 n=66
8. Adjusted Total ³	--	--	--	1263

¹ Percentages reported are adjusted for missing values. n=number of observations if different from row 1. Dollar values are measured in 1986 dollars.

² Derived from number of eyes (one or both), average insurance coverage for hospital services by group, and an assumed average cost of \$650 per procedure.

³ Line 8 gives the average expected medical cost of surgery for patients who undergo surgery, based on the sum of additional doctor visits for A and C, incremental prescription costs for B, other medical expenses for C, assuming 60% of cases have surgery on both eyes and 40% have surgery on only one eye, and a 30% rate of follow-up surgery.

Table 6-3 (continued)
II. Total Cost To Society

Group	A (Pre-Surgery)	B (Between Surgery)	C (Post- Surgery)	All Respondents
Number of Observations	7	20	39	66
<u>COST CATEGORY</u>				
1. Additional Doctor visits	\$44 (26)	\$52 (14)	\$26 (7)	\$36 (6)
2. Driving Costs (same as for individual)	22 (9)	59 (30)	43 (16)	46 (13)
3. Changes in Eyeglasses Prescription	46 (30)	119 (21)	18 (6)	52 (10)
4. Surgical Expenses (actual and near-term expected)				
a. One Eye Only	3,500 (0) n=3	--	3,300 (183) n=12	3,340 (147) n=15
b. Both Eyes	7,000 (0) n=4	6,528 (404) n=20	6,337 (438) n=27	6,189 (300) n=51
5. Follow-up Surgery Expenses	-- --	650 (0) n=3	789 (74) n=14	765 (62) n=17
6. Other Medical Expenses	-- --	132 (104) n=6	119 (23) n=12	123 (36) n=18
7. Total	3,612 n=7	6,896 n=20	5,529 n=39	5,612 n=66
8. Adjusted Total				5.617

- 1 Percentages reported are adjusted for missing values. n=number of observations if different from row 1.
- 2 Based on an assumed average cost of \$650 per procedure.
- 3 Line 8 gives the average expected cost of surgery for patients who undergo surgery, based on the sum of additional doctor visits for A and C, incremental prescription costs for B, other medical expenses for C, assuming 60% of cases have surgery on both eyes and 40% have surgery on only one eye, and a 30 percent rate of follow-up surgery.

expected expenses. If the individual did not know the total costs related to surgery, \$3,500 was assumed for cataract surgery and \$650 was assumed for follow-up surgery, which may be conservative (see Chapter 4).

Table 6-3 Row 7 (both Parts I and II) presents the samplewide weighted average medical expenses incurred plus surgery expenses expected to be incurred. This figure assumes that 60 percent of all those undergoing surgery during their lifetime will do so in both eyes. This figure is also based upon the average expenses by category for all individuals, rather than by those who incur those expenses as in several previous rows of the table.

The figures in Row 7 require several adjustments for use in assessments covering the total damage of cataracts. For example, those individuals in the pre-surgery phase will ultimately also incur expenses associated with the surgery and post-surgery phases, unless they do not undertake surgery. Row 8 presents an adjusted total that is more representative of the typical average medical costs incurred due to cataracts, based upon costs incurred through all phases of treatment. The adjustments include the incremental doctor visits for both pre- and post-surgery phases, incremental prescription costs based upon those in Group B, the estimate of "other medical expenses" based upon those in Group C, and a 30 percent rate of follow-up surgery (See Table 6-2 and Section 6.8).

The adjusted total medical cost estimates may still have inaccuracies that need to be recognized. Most importantly, these estimates apply only to those individuals who undergo surgery on at least one eye (results in Section 6.8 imply this amounts to 75 to 90 percent of the affected population). The medical costs for those who do not undergo surgery can be expected on average to be lower. Further inability to accurately recall all expenses and their amounts add inaccuracy.

Several interesting findings can be determined from Table 6-3. They include:

- o Surgery related expenses account for about 90 percent of the total medical costs to society, yet only about 55 percent of total medical costs incurred by the affected individual. Due to substantial insurance

coverage for surgery, many individuals pay virtually nothing for surgery.

- o Total medical expenses incurred by the individual comprise about 22 percent of total medical expenses incurred by society.
- o Surgery expenses for those with both eyes operated on are approximately double those for individuals with only one eye operated on.
- o The total value estimates are somewhat higher than those previously estimated in the literature (see Chapter 4) due to expenses not captured through available data. ~~However, the~~ surgical costs reported nationally and for Denver in Chapter 4 are quite consistent with the comparable costs reported in the survey. This suggests the survey is not misrepresentative in dealing with treatment costs.

6.3 CATARACT PATIENT SURVEY - WORK LOSS AND COST OF ILLNESS MEASURES

Statistics on work loss are presented in Table 6-4. As some questions were only asked of individuals in different Groups (A, B, or C) and as only a portion of the sample was employed, the work loss estimates are based upon very limited sample sizes. Samplewide, 55 percent of the respondents considered themselves employed, with 40 percent employed for wages and salaries and 15 percent self-employed. It is important to note that many individuals of retirement age now consider themselves self-employed in investments, real estate, writing and other occupations. Samplewide, only 14 percent attributed any lost earnings to cataracts. This figure may somewhat overstate the percent affected in the population due to the under-representation of those 65 years of age or older.

Work loss arises from working fewer hours, receiving lower wages than would have otherwise been earned, sick and vacation time taken to treat cataracts, and volunteer work lost to society. For those with some form of work loss, the annual average loss is about \$5,600, as reported in row 6b. Samplewide, across the employed and unemployed, the average work loss is about \$680. Lost income due to sick and vacation time used for surgery in the adjusted total is an

Table 6-4
Annual Work Loss Due to Cataracts¹

Group	A (Pre-Surgery)	B (Between Surgery)	C (Post- Surgery)	All Respondents
Number of Observations	7	20	39	66
1. Number Employed	0	10 (50%)	26 (60%)	36 (55%)
2. Number with Work Loss (past or present)	0	4	5	9
3. Number Changing Jobs	--	0	2	2
4. Number Quitting	--	0	2	2
5. Number Working Fewer Hours	--	4	1	5
6. Of those with work loss:				
a. Average % loss in income	--	8% n=3	37% n=5	26% n=8
b. Average \$ loss in income	--	\$850 n=3	\$8,460 n=5	\$5,606 n=8
7. Average number of sick or vacation days used annually for surgery by the employed	--	8.5 n=2	--	8.5 n=2
8. Volunteer Work Loss				
a. % With loss (past or present)	--	11% n=2	10% n=4	9% n=6
b. Average decline in hours per month for those affected	--	48 n=2	20 n=4	26 n=6
c. Average samplewide 1-year dollar loss valued at \$3.65/hr.	--	\$210	\$76	\$116
9. Adjusted sample weighted work loss ³				
a. to the individual	--	--	--	\$1,043
b. to society	--	--	--	\$1,159

Table 6-4 (continued)
Annual Work Loss Due to Cataracts

Group	A (Pre-Surgery)	B (Between Surgery)	C (Post- Surgery)	All Respondents
10. Of those employed ⁴				
a. % with reduced enjoyment at work	--	25 n=3	--	25
b. % with reduced productivity at work	--	20 n=2	--	20

- 1 Dollar values are measured in 1986 dollars.
- 2 This question was asked only of those in group B who were employed and planning surgery within the next year.
- 3 The adjusted samplewide weighted work loss is based on assumptions of 50 percent employment, \$24,700 average annual wages and 90 percent surgery rate for those employed. For the individual the calculation is the sum of \$680 average loss in annual income due to inability to work and \$363 average loss due to sick and/or vacation applied to surgery. For society, the calculation adds the average samplewide one-year dollar loss of \$116 volunteer work.
- 4 Only asked of Group B respondents.

average of \$878 for those affected and \$~~363~~ samplewide, based upon 50 percent employment, a 90 percent surgery rate and average annual income from employment of \$24,700, and is included in both the individual and society adjusted totals. Averaged across all patients (employed or not), the mean work loss/sick leave value for one year is \$1,043 (680 + 363).

Lost volunteer work, which is included in the adjusted society total, but not the adjusted individual total, is based upon annualized number of hours affected per month in the year prior to surgery.

Results of interest include:

- o The principle component of work loss value comes from lost income due to inability to work.
- o The work loss incurred by the affected individual, as measured and attributed, amounts to about 90 percent of the total to society.

Table 6-5 combines the estimated medical expenses and work loss estimates to form Cost-of-Illness (COI) damage measures for the individual and society. It should be noted that these include cost components often omitted in traditional COI measures found in the literature. The estimates in these tables are taken from the adjusted totals across all phases of treatment as reported in Tables 6-2 and 6-4. The significant findings are:

- o The medical expenses comprise about 55 percent of the COI total for the affected individual and 83 percent for society as a whole.
- o The COI for the individual is about 34 percent of the total social COI.
- o The COI for the individual and society are estimated to be approximately \$2,306 and \$6,776 respectively, based upon a weighted average of surgical treatments and employment status.

The estimates in Table 6-5 are for those individuals who undergo surgical treatment for one or both eyes. The COI for those who do not undergo surgery is

Table 6-5
Total Cost-of-Illness Estimate¹

	Paid by the Individual	Paid by Society
1. Medical Expenses ²	\$1,263	\$5,617
2. Work Loss	\$1,043	\$1,159
TOTAL Cost Of Illness	\$2,306	\$6,776

¹ Dollar values are measured in 1986 dollars.

² Reflects the weighted average cost for one eye and both eyes.

likely to be lower. This is because no surgery expenses are incurred by these individuals, and because individuals who forgo surgery are more likely to not be employed, thus reducing work loss.

6.4 CATARACT PATIENT SURVEY - CHORES AND LEISURE IMPACTS

Table 6-6 summarizes the results concerning the impacts of cataracts on chores and leisure. Over half of all respondents indicated that cataracts interfered with their ability to do chores or to participate in desired leisure activities. About a third indicated they used paid or unpaid caregiving services or had other expenses associated with cataracts, with a total samplewide value of these services of about \$146 annually during the period just before, during and just after surgery. Based upon the discussion in Section 3.4, unpaid caregiving is valued at the minimum wage of \$3.65/hr. Assuming only a one year period of need for these services encompassing the period just before, during and just after surgery, and adjusting to incorporate the Group C estimate of "other expenses" to reflect the total over the treatment period, the total is about \$166. This figure will understate true damages for these impacts if the average period of need is more than one year, as might be the case for those individuals who do not seek surgical treatment of their cataracts.

6.5 CATARACT PATIENT SURVEY - RANKINGS AND TOTAL VALUATION RESULTS

The rankings of the different components of damage related to cataracts are summarized in Tables 6-7 and 6-8. These rankings apply to the relative importance of damage categories as seen from the perspective of the affected individual, not society. Overall the rankings are as follows:

<u>Rank</u>	<u>Category</u>
1 (tie)	Leisure impacts.
1 (tie)	Concerns about eyesight, surgery and possible complications.
3 (tie)	Concerns about needing help from family and friends.

Table 6-6

Impacts of Cataracts on Chores, Caregiving, Leisure, & Other Expenses

Group	A (Pre-Surgery)	B (Between Surgery)	C (Post- Surgery)	All Respondents
Number of Observations	7	20	39	66
1. % with Chores affected	17	40	44	40
2. a. % Using Paid Services (past and present)	14 n=1	5 n=1	0	7 n=3
b. Average expense per year				
i. Those using services	\$120	\$144	--	\$132
ii. Samplewide	\$ 17	\$ 7	0	\$ 4
3. a. % Using Unpaid Help (caregiving)	29 n=2	40 n=8	21 n=8	27 n=18
b. Value per year at \$3.65/hr*				
i. Those using services	\$161	\$186	\$658	\$403
ii. Samplewide	\$ 46	\$ 74	\$135	\$110
4. % with any leisure affected	57	30	28	32
a. % with driving affected	43	30	23	27
b. % with reading affected	14	5	21	15
c. % with TV affected	14	5	5	6
d. % with other leisure activities affected	14	15	15	15
5. Other expenses ¹				
a. For those who have them	--	\$50 n=1	\$509 n=4	\$417 n=5
b. Samplewide	--	3	52	32
6. Total value of impacts for 2bii + 3bii + 5b, samplewide	\$63	\$84	\$187	\$146
7. Adjusted Total Value ²	--	--	--	\$166

* The social value of unpaid caregiving was set at the minimum wage. See Appendix D for additional discussion.

Table 6-6 - Continued
Impacts of Cataracts on Chores, Caregiving, Leisure, & Other Expenses

NOTES

¹ From survey, Section V, question 7. Responses include:

1. Mistake at work respondent had to pay for
2. Sunglasses needed because with improved vision eyes are sensitive to sunlight
3. New higher wattage light bulbs
4. Transportation from Nebraska to Denver and lodging
5. Automobile accident attributed to cataracts

² The adjusted total value in line 7 uses the Group C estimate of other expenses to reflect the expenses over the entire treatment period.

Table 6-7

Ranking of Impact Categories By Group

Group	A (Pre-Surgery)	B (Between Surgery)	C (Post- Surgery)	All Respondents	Overall Rank
Number of Observations	7	20	39	66	
<u>Impact Categories</u>					
1. Medical expenses:					
%Least Adverse	57	65	56	59	#3 (tie with 6)
%Somewhat Adverse	43	20	28	27	
%Most Adverse	0	15	15	14	
Average Rank	1.4	1.5	1.6	1.5	
2. Ability to earn income:					
% Least Adverse	86	80	67	73	#5 (tie with 3)
% Somewhat Adverse	14	20	23	21	
% Most Adverse	0	0	10	6	
Average Rank	1.1	1.2	1.4	1.3	
3. Ability to work for reasons other than income:					
% Least Adverse	71	70	77	74	#5 (tie with 2)
% Somewhat Adverse	29	20	15	18.	
%. Most Adverse	0	10	8	8	
Average Rank	1.3	1.4	1.3	1.3	
4. Leisure activities:					
% Least Adverse	14	20	41	32	#1 (tie with 7)
% Somewhat Adverse	14	35	21	26	
% Most Adverse	71	45	38	44	
Average Rank	2.6	2.3	2.0	2.1	
5. Expenses for services:					
% Least Adverse	57	90	92	88	#7
% Somewhat Adverse	29	10	8	11	
% Most Adverse	14	0	0	2	
Average Rank	1.6	1.1	1.1	1.1	
6. Concern about needing help from family & friends:					
% Least Adverse	29	70	64	62	#3 (tie with 1)
% Somewhat Adverse	0	15	31	22	
% Most Adverse	71	15	5	15	
Average Rank	2.4	1.5	1.4	1.5	
7. Concern about eyesight, surgery and possible complications:					
% Least Adverse	43	30	28	30	#1 (tie with 4)
% Somewhat Adverse	29	45	36	38	
% Most Adverse	29	25	36	32	
Average Rank	1.8	2.0	2.1	2.0	

Table 6-8

**Number of People Ranking Each Impact Category
as Most Important by Group**

Group	A (Pre-Surgery)	B (Between Surgery)	C (Post- Surgery)	All Respondents
Number of Observations	7	20	39	66
<u>Impact Categories</u>				
1. Medical expenses:	1	3	4	8
2. Ability to earn income:	0	0	6	6
3. Ability to work for reasons other than income:	0	2	0	2
4. Leisure activities:	4	8	12	24
5. Expenses for services:	0	0	0	0
6. Concern about needing help from family & friends:	3	1	0	4
7. Concern about eyesight, surgery and possible complications:	2	6	15	23
8. Other Impacts:	1	2	0	3

* Total does not add to 66 because six respondents had two answers and two respondents said none were most important.

- 3 (tie) Medical expenses.
- 5 (tie) Ability to earn income.
- 5 (tie) Ability to work for reasons other than income.
- 7 Expenses for services hired.

As is readily apparent, the COI damage components are in the middle to bottom of the rankings, suggesting that total value of the impacts of cataracts may substantially exceed those damages reported with COI measures. The rankings show a general consistency across those categories for which dollar damage estimates have been made. The ranking of medical expenses, work loss and expenses for services hired parallels the dollar estimates for these categories.

The total value estimates are summarized in Table 6-9. Comparisons across groups and measures is somewhat limited by the small sample size. Nevertheless, the results generally support the following significant conclusions:

- o The values for those in Group A (pre-surgery) are generally less than for those in Groups B and C, perhaps reflecting small sample size, lack of familiarity with the entire treatment process, or reflecting some uncertainty as to whether any surgery will be performed and whether this will be for one eye or both.
- o The RANKVAL estimates are, as expected, lower than the values reported by other calculations.
- o The FULLVAL, PIEVAL and MWTP2 values are generally quite comparable.
- o Based upon those in Groups B and C, the value held by the affected individual who undertakes surgery is, on average, between \$8,000 and \$15,000 with the preponderance of estimates falling in the \$12,000 to \$15,000 range.
- o Based upon the results for Groups A, B and C the value of damage for those who have cataracts with visual acuity of 20/30 or worse but who do

Table 6-9
Comparison of Total Value Measures of Cataracts By Group¹
(Mean and Standard error of Mean in Parentheses)

Group	A (Pre-Surgery)	B (Between Surgery)	C (Post- Surgery)	All Respondents
Number of Observations	7	20	39	66
1. RANKVAL	\$1,746 (529)	\$ 4567 (1621)	\$3,901 (936)	\$3,875 (740)
2. FULLVAL	\$11,500 (2614) n=7	\$15,676 (3742) n=17	\$15,212 (3496) n=25	\$14,842 (2213) n=49
3. PIEVAL	\$ 6,294 (4933) n=7	\$11,450 (3569) n=20	\$13,790 (5299) n=38	\$12,263 (3314) n=65
4. MWTP2	\$10,917 (7845) n=6	\$ 7,782 (2598) n=19	\$13,491 (2081) n=34	\$11,391 (1658) n=59

¹ Measured in 1986 dollars.
n = number of observations if different from row 1.

not undergo surgery is likely to be between about \$6,000 and \$15,000 or more. For some of these individuals the damages will not be severe enough to warrant surgery, resulting in lower values, while for others there may be reasons they cannot or will not undertake surgery that they would normally desire in order to avoid the impacts of cataracts.

Based upon the above, and the fact that between 70 and 90 percent of affected individuals will eventually have surgery, a reasonable point estimate of the average value of damage to the affected individual is \$12,000. The ratio of WTP to COI for the individual is approximately 4.25.

The total value of damage to society is equal to the value to the individual (assumed to average \$12,000) plus:

- o Medical expenses incurred by society but not paid by the individual. This is measured as the difference between the adjusted total medical expense for society and the individual. The average difference is \$4,354.
- o Work loss, volunteer time and other expenses incurred by society above what the individual ensures of \$246 (\$116 volunteer work loss plus \$130 unpaid caregiving)
- o Values held by others in society related to the impacts of cataracts to the affected individuals. Work by Needleman (1976) suggests the WTP of others to prevent an individual's premature death increases total WTP by 25 to 100 percent. No estimate for this value was made in this research. For sensitivity analysis purposes, we call this extra value Z and assume alternative values of Z equal to 0, 25 and 50 percent of the WTP of the affected individual.

Based upon the above, the estimated total social values of average damage for a cataract case using \$12,000 as the individual WTP are \$16,600 ($12,000 + \$4,354 + \$246 = 16,600$) when $Z=0\%$; \$19,600 ($12,000 \times 1.25 + 4,600$) when $Z=25\%$; and \$22,600 ($1.5 \times 12,000 + 4,600$) when $Z=50\%$. These values are 2.4 to 3.7 times the estimated total social COI measure reported in Table 6-5.

Table 6-10
Sociodemographic Characteristics of the Sample Population

Group	A (Pre-Surgery)	B (Between Surgery)	C (Post- Surgery)	All Respondents
No of Observations	7	20	39	66
1. Age				
% <55	14	20	36	29
% 55-64	29	45	38	39
% 65-74	29	10	15	15
% >74	29	25	10	17
2. Sex				
% male	14	55	51	48
% female	86	45	43	52
3. Marital Status				
% married	43	30	23	27
% single (includes widowed and divorced)	57	70	77	73
4. Average Household Size	1.57	2.05	2.25	2.12
5. Residence				
% who own	86	75	82	80
% who rent	14	20	18	18
% living in nursing home	0	5	0	2
6. Highest Level of Education Completed				
% elementary or high school	43	30	24	28
% vocational training or some college	29	30	37	34
% college degree or graduate work	29	40	40	38
7. Average Total Income	\$40,500	\$32,917	\$35,446	535,446

6.6 CATARACT PATIENT SURVEY - SOCIO-DEMOGRAPHICS

Socio-demographic characteristics of the sample are summarized in Table 6-10. The sample underrepresents the percent of cataract patients in age groups over 65 years of age. The average income of the group is about 10 percent higher than the average household income in the Denver metro area.

6.7 CATARACT PATIENT SURVEY - ADDITIONAL STATISTICAL ANALYSIS

To verify the validity and consistency of the damage category ranking and total WTP values from Section VI of the patient survey, several consistency checks were performed. The consistency checks are summarized in Table 6-11. In general, the analysis shows a strong correlation between the ranking of the most important impacts and other data in the questionnaire.

- o The impact of medical costs was ranked third overall. The consistency checks indicate medical expenses were consistently ranked as more adverse for those whose household medical expenses (MEDHH) were larger and for those whose medical expenses accounted for a larger portion of the total impacts (PIE).
- o The impact on ability to earn income was ranked fifth overall, and was ranked as a least-adverse impact by 73% of respondents. Those who were employed ranked this impact higher than those who were not employed, and those who claimed to be earning less due to cataracts ranked this impact higher than those who did not claim to be earning less due to cataracts.
- o The impact on ability to work at a job for reasons other than income or to do volunteer work also ranked fifth overall (tying with the impact on ability to earn income) and was ranked as a least-adverse impact by 74% of respondents. Impacts on ability to work at a job for reasons other than income or to do volunteer work ranked higher for those whose

Table 6-11
Consistency Checks¹

1. Household Medical Expenses (Ranking Category 1).

Ranking of Medical Expenses (R1)	Group A Mean		Group B Mean		Group C Mean		Mean for All Respondents	
	PIE	MEDHH	PIE	MEDHH	PIE	MEDHH	PIE	MEDHH
Least Adverse	19%	\$359	11%	\$956	10%	\$778	11% (n=38)	\$795 (n=39)
Somewhat Adverse	33%	\$403	30%	\$1395	22%	\$937	26% (n=18)	\$950 (n=18)
Most Adverse	- -	- - -	44%	\$1133	56%	\$2374	52% (n=9)	\$1960 (n=9)

2. Work Loss (Ranking Category 2)

Rank of Impact on Ability to Earn Income (R2)			Unemployed ²	Employed	Earning Less Due to Cataracts	Not Earning Less Due to Cataracts
Least Adverse	86%		64%		20%	79%
	(n=25)		(n=23)		(n=1)	(n=19)
Somewhat Adverse	14%		25%		40%	13%
	(n=4)		(n=9)		(n=2)	(n=3)
Most Adverse	0%		11%		40%	8%
			(n=4)		(n=2)	(n=2)

3. Impact on ability to work at a job or to do volunteer work for reasons other than income (Ranking Category 3)

<u>Volunteer Hours</u>	<u>Mean Rank of R3³</u>		<u>Standard Error of Mean</u>
Decrease	2.6	(n= 3)	.33
No Change	1.3	(n=58)	.07
Increase	1.3	(n= 3)	.33

Table 6-11 - Continued
Consistency Checks¹

4. Impact on chores and leisure activities (Ranking Category 4)

	<u>Mean Rank of R4</u>	<u>Standard Error of Mean</u>
Either Chores or Leisure Affected	2.3 (N=30)	.16
Neither Chores nor Leisure Affected	1.9 (N=35)	.13

5. Impact of Expenditures for services needed due to having cataracts (Ranking Category 5)

	<u>Mean Rank of R5</u>	<u>Standard Error of Mean</u>
Services Used	1.18 (n=22)	.08
Services Not Used	1.11 (n=44)	.06

6. Impact of concerns about needing help from family and friends (Ranking Category 6)

	<u>Mean Rank of R6</u>	<u>Standard Error of Mean</u>
Help Needed	1.78	.21
Help Not Needed	1.18	.12

Table 6-11 - concluded
Consistency Checks¹

7. Impact of Concerns about eyesight, surgery, and complications (Ranking Category 7)

<u>Rank of Concerns about eyesight, surgery and complications (R7)</u>	<u>Group A</u>	<u>Group B</u>	<u>Group C</u>	<u>One Eye Affected</u>	<u>Both Eyes Affected</u>
Least Adverse	43%	30%	28%	31%	30%
Somewhat Adverse	28%	45%	36%	56%	32%
Most Adverse	28%	25%	36%	13%	38%
Mean Rank of R7	1.86	1.95	2.08	1.8	2.08
Standard Error of Mean Rank	.34	.17	.13	.17	.11

8. Other Impacts (Ranking Category 8).⁴

<u>Rank of Other Impacts (R8)</u>	<u>Group A</u>	<u>Group B</u>	<u>Group C</u>	<u>One Eye Affected</u>	<u>Both Eyes Affected</u>
Number Ranking R8 Least Adverse	0	0	0	0	0
Number Ranking R8 Somewhat Adverse	0	1	6	3	4
Number Ranking R8 Most Adverse	1	1	2	0	4

¹ Variable names as defined in report. Groups A, B, C as defined in report.

² = the total number of observations in a cell.

³ No respondents were unemployed or took an early retirement because of cataracts.

⁴ Average of 1 (least adverse), 2 (somewhat adverse) and 3 (most adverse).

⁵ Most comments elicited by this question were elaborations on one or more of the other impact categories already discussed. Respondents in Group C and with both eyes affected had the most to say. (See the summary of comments in Appendix B.)

volunteer hours declined due to cataracts than for those whose work hours were not affected by cataracts.

- o The impact of cataracts on leisure activities was ranked first (most important) overall. Leisure impacts were ranked higher by those who indicated that cataracts interfered with their chores or leisure activities than by those who said their chores and leisure activities were not affected by their cataracts.
- o The impact of expenses for services hired was ranked seventh (least important) overall, and was ranked as a least-adverse impact by 88% of respondents. The impact of expenditures needed for services ranked higher for those using services than for those not using services.
- o The impact of concerns about needing help from family and friends was ranked third overall (tying with medical expenses). Concerns about needing help from family and friends ranked higher for those who needed help than for those who did not need help.
- o The impact of concerns about eyesight, surgery and possible complications was ranked first overall (tying with leisure impacts). These concerns were ranked higher by post-surgery respondents than by pre-surgery and in between-surgerys respondents, and ranked higher by those with both eyes affected than by those with just one eye affected.

7.0 FRAMEWORK FOR CALCULATING AGGREGATE ECONOMIC DAMAGE
MEASURES FOR CHANGES IN UV-B INDUCED CATARACTS

7.1 INTRODUCTION

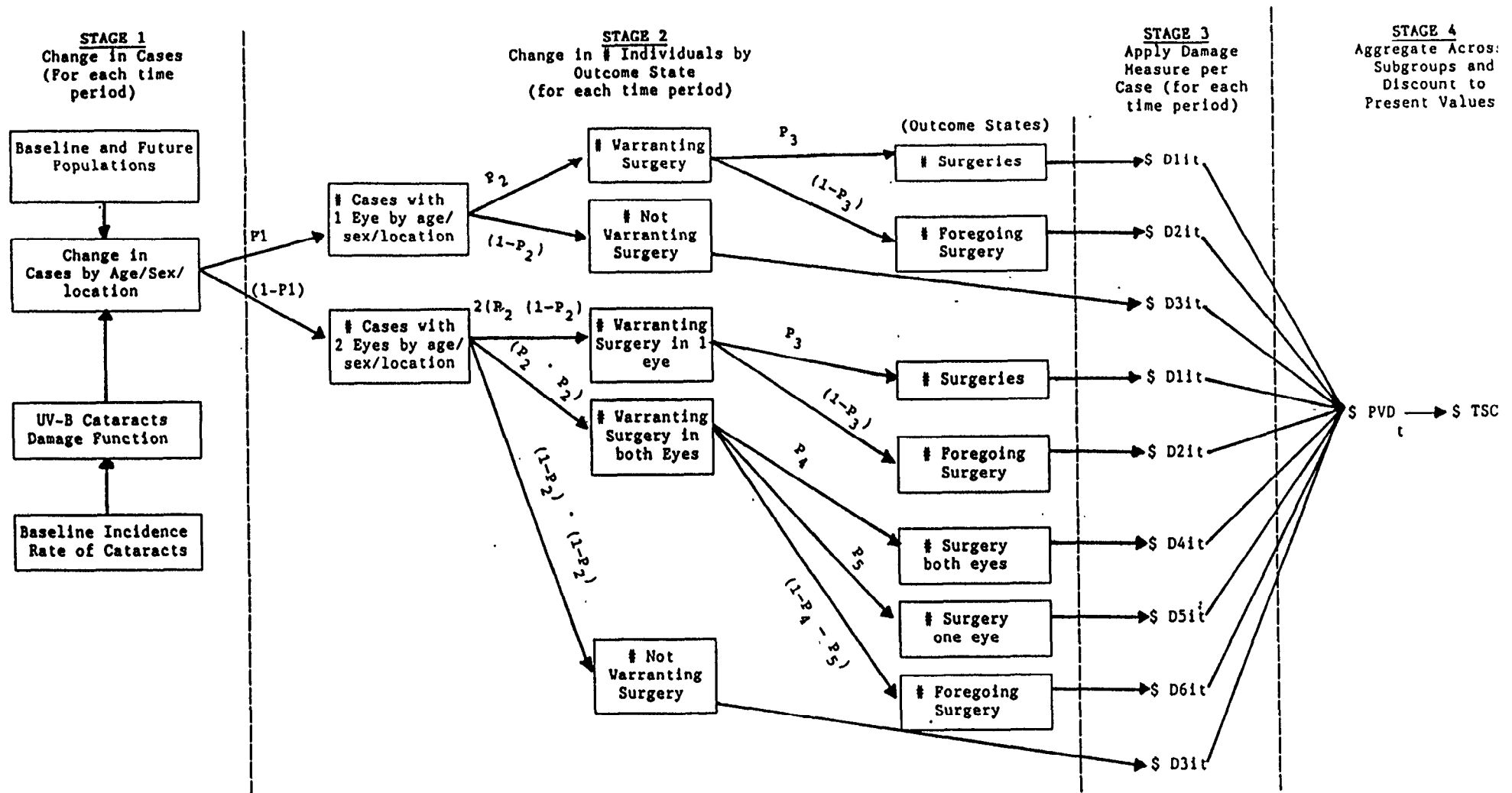
A framework is presented in Section 7.2 for calculating aggregate economic damages for future changes in the incidence of cataracts due to changes in UV-B radiation. Much of the information necessary to implement the framework is not available in the literature. To illustrate the application of framework, a limited survey of ophthalmologists was conducted to obtain preliminary assumptions and the value estimates in Chapter 6 are used. Based upon this highly simplified application the potential present value of damages may be on the order of magnitude of several billion dollars.

7.2 FRAMEWORK

A framework for assessing the present value of economic measures of future damages is presented in Figure 7-1. The framework combines a simple aggregation process with a probability tree. The probability tree indicates, for each age/sex/location/time group, the probability of alternative outcome states and the resulting value. The aggregation process in Stages 1 and 4 then allows one to aggregate across probable outcomes and age/sex/location/time groups to arrive at the present value of the change in total social damage for a change in health status.

STAGE 1: Changes in the Total Number of Cataract Cases. Several steps are required at this stage. First, the baseline rate of cataract incidence by age/sex/location must be combined with estimates of UV-B induced changes in cataracts to estimate the change in the percent of each population group in each time period that will develop cataracts. Because any change in UV-B will take some time to reach the proportional percentage change in incidence of cataracts, time sequencing of the UV-B change and resulting change in cataracts will be an important consideration.

Figure 7-1
Framework to Calculate Aggregate Cataract Damages
Due to Changes in UV-B*



- * Notes
- P_1 = % of Cataract patients with cataracts in only one eye
 - P_2 = % of catarous eyes warranting surgery
 - P_3, P_4, P_5 = % of catarous eyes warranting surgery that get surgery, depending upon whether one or both eyes are affected
 - \$ Djit = Weighted dollar estimate of damages for subgroup j (surgery, no surgery, one eye vs two eyes etc.), Age/Sex/Location
 - \$ D_jit = weighted weighted average across treatment procedure and after cataracts effects rates and may be either a COI on WTP measure
 - \$ DVDt = present value of economic damage estimate in time period t
 - \$ TSC = Aggregate of present value of economic damage estimate in time period t

Next, the rate of change in incidence by age/sex/location in each future time period can be combined with projected population demographics to estimate the total number of additional cases in each time period by age/sex/location group.

Data for this step include a UV-B damage function, which is partially addressed in Chapter 2 and in EPA (1986); baseline incidence rates, which are provided in Chapter 2; and population forecasts available through the Bureau of Census.

STAGE 2: Calculation of the Change in the Number of Cataract Patients by Outcome State. Surgical decisions and costs may differ depending upon whether the disease is unilateral or bilateral. Further, baseline incidence data, which considers cataracts in both eyes within a 5-year period as one case, must be correctly interpreted. The results of the Ophthalmologist's survey (questions 1 and 2) address these issue for different age groups. The number of surgeries and the corresponding costs will depend upon whether one or both eyes will merit surgery, decisions to operate on one or both eyes, and the timing of the surgeries. The probabilities that surgery will both be warranted and undertaken (by age) can be derived from the Ophthalmologist's survey (questions 3 through 7).

STAGE 3: Apply Economic Damage Measure Per Case. The economic damage measure will vary depending upon the age, sex, employment status, number of eyes affected, surgery decisions, type of surgical procedures applied, probability of after-cataract and the like. Most appropriately, a figure weighted by probabilities of alternative outcomes should be applied. Further, either a total societal or individual measure could be employed based upon a WTP or COI approach.

Information for this stage is derived from the survey of cataract patients as well as the Ophthalmologist's survey (questions 8 through 10).

STAGE 4: Aggregation Across Age/Sex/Location Subgroups and Discounting to Present Values. For each time period, damages for each age/sex/location subgroup would be aggregated. The present value of damages for each time period are summed to provide a total damage estimate of the present value of changes in cataracts induced by changes in UV-B.

7.3 OPTHALMOLOGISTS SURVEY

The sample of cataract patients interviewed is relatively small and may be unrepresentative of the cataractous population as a whole. Unfortunately, limited data exists about the characteristics of this population group other than prevalence rates by age and sex (see Chapter 2), thus limiting the ability to evaluate the representativeness of the patient survey or to apply values to general cataractous population for aggregate value measures. The only incidence data available was derived from prevalence data. This incidence data has limitations in use for an aggregate damage assessment because a case is defined as an individual diagnosed during a 5-year period, regardless of whether 1 or two eyes are diagnosed during the period, which affects the treatment costs. Further, an individual who has both eyes diagnosed, but more than 5 years apart is treated as two separate cases. Therefore, additional knowledge about the formation of cataracts is necessary to interpret this incidence data. Limited data also exists about the percent of patients receiving alternative treatments.

A limited mail survey of Denver area ophthalmologists was conducted to round out the information available from the literature and from the panel of cataract patients. The survey instrument follows the National Eye Institute definition of patients with cataracts as having impairment resulting in visual acuity of 20/30 or poorer, or otherwise impairing vision.

The survey instrument, included in Appendix C, addresses the following issues:

- o The percent of cataract patients eventually developing cataracts in both eyes, by age of first diagnosis.
- o The average time period between diagnoses of the first and second eye for individuals with cataracts in both eyes.
- o The percent of individuals who will need, and who will get, surgical treatment of their cataracts, depending upon age and whether they have cataracts in one or both eyes.

- o The percent of patients requiring secondary cataract treatment by type of original procedure.
- o Within one year before and after surgery, the number of visits to the doctor's office that are not covered in the surgical fee.

The survey was mailed January 8, 1987 to 55 ophthalmologists in the Denver area with responses requested by January 17, 1987. Due to the consistency of early responses plus budget and time limitations, no mail or telephone follow-up were conducted. Eleven completed forms were received in the requested 9 day response period.

7.4 OPHTHALMOLOGIST SURVEY RESULTS

The results of this survey reported in Table 7-1 include the mean and standard error of the responses, using the codes on the survey form (Appendix B), and the approximate implied percentages. Although some physicians have differing opinions and experiences, or possibly misunderstood a question, the consensus of opinion is quite tight as reflected by the relatively low standard errors surrounding the mean responses. Among the significant results are:

- o Most individuals develop cataracts in both eyes (80 to 90 percent, from question 1) and both eyes are generally (over 90 percent of the time) diagnosed within 5 years or less (from question 2).
- o Onset of cataracts at older ages results in significantly reduced need for surgery, presumably due to reduced demand for visual acuity and reduced life expectancy (from questions 3 and 5). About 60 percent of those over 65 years old will see their cataracts progress to the point of warranting surgery whereas the same is true for about 80 percent of those developing cataracts at ages under 45.
- o The older the individual is when impairment is sufficient to warrant surgery, the less likely surgery will be undertaken (from questions 4, 6 and 7). For example, individuals over 65 years of age when impairment

Table 7-1

Summary of Ophthalmologists Survey Results

Question	Group	Results*			Standard Error of Mean	Approximate Implied Mean %
		Minimum Value	Maximum Value	Mean Value		
1. % Developing Cataracts in both eyes versus one eye	Age of First Diagnosis					
	<45	2	5	4.67	.33	83%
	45-65	4	5	4.89	.11	89%
	>65	4	5	4.89	.11	89%
2. Time between Diagnosis for those with cataracts in both eyes	Time Interval					
	<1 Year	0	5	2.7	.50	40%
	1-2 Years	0	3	2.0	.29	30%
	2-5 Years	1	3	1.9	.20	25%
	>5 Years	0	2	1.0	.24	10%
3. Patients with Cataracts in one eye - % warranting surgery	Age of First Diagnosis					
	<45 Years	4	5	4.62	.18	82%
	45-65 Years	3	5	3.87	.12	67%
	>65 Years	3	5	3.75	.25	65%
4. Patients with Cataracts in one eye & warranting surgery--% who do not have surgery	Age of Impairment					
	<45 Years	1	3	1.25	.25	15%
	45-65 Years	1	3	1.62	.25	22%
	>65 Years	1	3	2.12	.26	32%
5. Patients with Cataracts in both eyes--% warranting surgery in both eyes	Age of First Diagnosis					
	<45 Years	1	5	4.33	.44	76%
	45-65 Years	2	5	3.78	.32	66%
	>65 Years	2	5	3.44	.29	59%
6. Patients Warranting surgery in both eyes--% getting surgery in both eyes	Age of Impairment					
	<45 Years	4	5	4.89	.11	89%
	45-65 Years	4	5	4.44	.18	78%
	>65 Years	3	5	4.00	.29	70%

Table 7-1 - Continued
Summary of Ophthalmologists Survey Results

Question	Group	Results				
		Minimum Value	Maximum Value	Mean Value	Standard Error of Mean	Approximate Implied Mean %
7. Patients warranting surgery in both eyes--% getting surgery in only one eye	Age of Impairment					
	<45 Years	1	3	1.38	.26	18%
	45-65 Years	1	3	1.88	.32	28%
	>65 Years	1	4	2.38	.38	38%
8. % of surgery patients having complications requiring follow-up surgery	Secondary Cataracts					
	Extracapsular Ext.	1	3	2.00	.23	30%
	Intracapsular Ext.	0	1	.89	.11	8%
	Other Complications					
	Extracapsular Ext.	1	2	1.11	.11	12%
	Intracapsular Ext.	1	2	1.11	.11	12%
9. % of those having surgery on both eyes--% at different time intervals	Time Interval					
	<6 Months	0	4	1.89	.45	28%
	6 mos-1 year	2	3	2.22	.15	34%
	1-2 Years	1	3	1.78	.22	26%
	2-5 Years	0	3	1.33	.29	16%
	>5 Years	0	2	1.00	.17	10%
10. Average number Doctor visits within 1 year of surgery not covered in surgery fee	All Patients	1	8	3.56	.66	--
11. % where surgery also improves nearsightedness or farsightedness	All Patients	3	5	4.22	.28	78%

* Response categories for all questions except # 10 are: 0=0%, 1=0-20%, 2=21-40%, 3=41-60%, 4=61-80%, 5=81-100%. The minimum, maximum, mean and standard errors refer to these code values. The last column gives the approximate average % implied by the responses. Results based upon a sample of 9 respondents. Some categories do not sum to 100% due to rounding.

occurs are about 2 and 1.5 times as likely, respectively, to forgo surgery as those with impairment occurring at ages under 45, or between 45 and 65.

- Of those with impairment warranting surgery in both eyes, those over 65 are significantly more likely to undergo surgery in only one eye (from questions 6 and 7).
- The post-surgery complication rate is significant (about 30 percent) for extracapsular extraction, but otherwise is trivial (from question 8).
- Those undertaking surgery in both eyes normally do so within 2 years (from question 9).
- 3 to 4 doctor visits occur within a one-year period before and after surgery that are not included in the surgery fee.
- 70 to 80 percent of individuals undertaking surgery also have the benefit of improved nearsightedness or farsightedness (from question 11).

The distribution of cataract cases by outcome and by age, summarized in Table 7-2 below, is based on the combined probabilities revealed in the survey and prevalence figures from the National Health and Nutrition Examination Survey (see Table 2-2). These results should be interpreted as preliminary since they are based upon a limited sample size and because of imprecision inherent in the survey response codes.

7.5 APPLICATION

Sensitivity Analysis

Aggregate damage calculations may be sensitive to many of the inputs and assumptions required to implement the framework. Any extensive application

Table 7-2
Distribution of Cataract Cases By Outcome and Age

Outcome State	Percent of Those Individuals With Cataracts by Age Group			
	<45	45 - 64	>65	All Ages ¹
1. Surgery never warranted	6%	13%	17%	15%
2. Surgery will be warranted in one or both eyes but never undertaken.	5%	7%	10%	9%
3. Surgery will be warranted in one or both eyes and undertaken in only one eye	35%	36%	34%	35%
4. Surgery will be warranted and undertaken in both eyes.	54%	44%	39%	42%

¹ Percentages reported in the individual age groups are from the Ophthalmologist survey. Percentages for the all ages category are based on prevalence figures from the National Health and Nutrition Examination Survey of 1971-1972, (presented in Table 2-2), excluding the age groups 1 to 5 and 6 to 11. Prevalence figures for cataract cases in the age group >74 are not available from NHANES.

should consider the sensitivity of the results to changes in selected inputs including:

- o The damage function relating changes in UV-B through time to changes in cataracts through time.
- o Changes in the presumed baseline incidence rate of cataracts.
- o The assumed future probabilities of surgery, treatment options, surgical consequences and costs.
- o The selected population growth rates and the discount rate.

Limitations

Use of the framework is limited by current estimates of incidence rates, treatment procedures, and damages. As time progresses many of these factors may change. Baseline incidence rates may increase (due to other aggravating factors) or decrease (due to increased mitigating behavior). It is likely that treatment procedures will continue to be more efficient, effective and easier with fewer post-surgical complications and increased positive benefits of improving eyesight, and it is likely that out-of-pocket costs and total damages will decrease.

Simplified Applications

The approach may be presented mathematically as:

$$TSC = \sum_{t=to}^T \sum_{s=1}^S \Delta N_{st} \sum_{i=1}^I P_{ist} \cdot D_{ist} / [(1+r) ** (t-to)]$$

where:

TSC = Present value of Total Social Costs for changes in Cataracts due to changes in UV-B

Σ = summation operator

- t = Index of time
- t₀ = Current Period
- T = Maximum future time period of interest
- s = Total number of Sociodemographic groups
- ΔN_{st} = Change in the number of individuals predicted to have cataracts in group s in time period t.
- i = Index of Cataract outcome states
- I = Total number of outcome status considered
- P_{ist} = Conditional probability of outcome state i for group s in time t, equal to the combined probability of all intermediate outcomes (P_1 to P_5) leading to outcome state i
- D_{ist} = damage measure for outcome state i for group s in time t
- r = discount rate to determine present values

A highly simplified application has been employed to estimate the likely order of magnitude of the economic measures of damage for increased cataract cases due to increases in UV-B. For simplicity, the following assumptions were used.

1. Starting 20 years hence the rate of cataract incidence is presumed to increase by alternative rates of 5% and 10%, and remain at the higher rate indefinitely ($\Delta N = 0$ for $[t - t_0] < 20$). The alternatives of 5% and 10% are based upon discussion in Chapter 2, Section 3.
2. The rate of increase in the incidence of cataracts is constant for all population groups. For example, if the baseline incidence rates are 20 percent, a 10% increase results in new incidence rates of 22 percent and so forth.
3. The population composition is assumed not to change (because of the aging of the baby boomers, this assumption underestimates the total number of future cases). As a result of assumptions 2 and 3:

$$\sum_{s=1}^S \Delta N_{st} = \text{either 5 or 10\% of current cases/year.}$$

4. $\sum_{i=1}^I (p_{tsi} D_{tsi}) = \X is assumed (the approximate weighted mean WTP for the conditional probable damage across outcome states for all affected individuals in all time periods, and alternative discount rates (r) of 4 and 8 percent are employed).

As a result, the simplified order of magnitude estimate equals $(.05 \text{ or } .10) \times (\text{current cases per year of } 600,000) \times (\text{present value discount factor for a stream of damage from year 20 to infinity using either } r = .04 \text{ or } .08; \text{ these factors equal } 11.41 \text{ and } 2.68) \times \$16,500$ (minimum estimate of Total Social WTP).

The estimated aggregate present value of future damages under these sets of simplified assumptions and procedures are:

1. 10 Percent Rate of Change in Cataract Incidence and 4 Percent Discount Rate: \$11.5 billion $(.1 \times 600,000 \times 11.41 \times \$16,500)$.
2. 10 Percent Rate of Change in Cataract Incidence and 8 Percent Discount Rate: \$2.6 billion $(.1 \times 600,000 \times 2.68 \times \$16,500)$.
3. 5 Percent Rate of Change in Cataract Incidence and 4 Percent Discount Rate: \$5.7 billion $(.05 \times 600,000 \times 11.41 \times \$16,500)$.
4. 5 Percent Rate of Change in Cataract Incidence and 8 Percent Discount Rate: \$1.3 billion $(.05 \times 600,000 \times 2.68 \times \$16,500)$.

Based upon these very preliminary calculations, damages in the low billions might be expected if the full framework were applied.

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A Simple Caregiver Model

Introduction

For some individuals, the occurrence of cataracts requires the provision of caregiving from paid providers, family and friends. The value of paid caregiving is most easily valued at the price paid. A model for the value of unpaid caregiving is presented below. As a result of the complications in valuing caregiving, an operationally effective strategy is to value caregiving at a fraction of the family member wage in alternative employment or to use minimum wages. The latter strategy is the approach employed in the empirical analyses in Chapter 6.

The Model

One can model caregiving choices and values assuming:

$$U = U(Y-M, V, tL, tg, X, Z)$$

$$T = tg + tw + tL$$

$$Y = w \cdot tw = P_x \cdot X + M$$

$$M = M(P_m, Y, tg)$$

where:

$$\partial U / \partial Y > 0, \partial U / \partial M < 0, \partial U / \partial V > 0, \partial U / \partial tL > 0$$

$$\partial U / \partial tg \times 0, \partial U / \partial X > 0, \partial U / \partial Z \times 0, \partial M / \partial P_m < 0, \partial M / \partial Y > 0, \partial M / \partial tg < 0$$

and where:

U = Utility of caregiver

V = Utility of others, which may be a function of the other individuals' health status and which may affect the enjoyment and activities of family members. In this case, the utility of individuals is interdependent.

P_m = Price of cataract related paid services
 M = Family expenditures related to cataracts
 Y = Total Income
 T = Total Time
 t_g = Time spent in caregiving
 t_w = Time spent in work for income
 t_L = time spent in leisure
 w = Wage rate for time at work
 X = other goods and services
 P_x = Price of other goods and services
 Z = Other socio-economic variables

The caregiver may decrease M by increasing t_g , but this comes at the expense of less t_L and t_w , which directly or indirectly reduce utility. In and of itself, caregiving may be positively or negatively valued as an activity. However, it is likely that time spent together with an individual in leisure activities who does not have cataracts yields the same or more utility than time spent giving care to the individual who has cataracts.

Optimizing the above model yields the result that caregiving will be undertaken up to the point where:

$$\frac{\partial U}{\partial M} \frac{\partial M}{\partial t_g} \geq - \frac{\partial U}{\partial Y} \frac{\partial Y}{\partial t_g} - \frac{\partial U}{\partial t_L} \frac{\partial t_L}{\partial t_g} + \frac{\partial U}{\partial t_g}$$

which states that the caregiving will be provided up to the point where the utility of expenditures avoided is greater than the utility of income forgone plus utility of time spent in caregiving rather than leisure.

The individual will choose the type of caregiving that maximizes expenditures forgone and minimizes the utility value of reductions in income and changes in leisure and caregiving time.

In this simple model, the dollar value of M avoided equals the upper bound value of the amount of caregiving provided, t_g (however, M may not be an upper bound, as discussed below under "A Complication"). If utility is reduced or not

changed by time spent in caregiving rather than in other leisure activities, then work loss of the caregiver represents a lower bound value of tg . If utility is increased by time in caregiving rather than in other leisure activities, then work loss may overstate both M and the value of tg .

A Complication

The interdependent nature of the utility functions of the affected individual and the caregivers may affect the analysis. If, for example, the cataract patient dislikes paid professional caregiving in deference to caregiving by family members, and this disutility then indirectly enters the utility function of the caregiver, then M may over- or understate the combined value of caregiving to the patient and the caregiver depending upon the caregiver's relative value of time in caregiving versus other leisure activities. Conversely, if the patient prefers professional caregiving, perhaps finding it undesirable for other family members to have to give care rather than undertake other activities, then M again overstates the value of tg by an amount greater than when this complication was not considered.

The model, combined with these psychological considerations, suggests a strategy for estimating caregiving values by family members. First, all unpaid caregiving by family members and others needs to be identified and apportioned to that which would occur without cataracts in the family. Many of these services can be valued by the research team. Potential work loss (paid work that would likely be done if caregiving was not being provided) by the caregiver needs to be identified. Finally, attitudes regarding caregiving in the part of the patient and caregiver would be useful to ascertain, but these questions would have to be carefully designed and responses cautiously evaluated if included in any analysis.